Sheet (8)

[1] Given the Following NLPF,

$$H(s) = \frac{1}{s+1}$$

use bilinear transformation to design a corresponding digital high pass filter with cutoff frequency of 50 Hz and sampling rate of 1 KHz.

[2] Design a second order digital high pass filter with the following specifications:

- cutoff frequency of 1.6 KHz
- A sampling frequency of 4 KHz

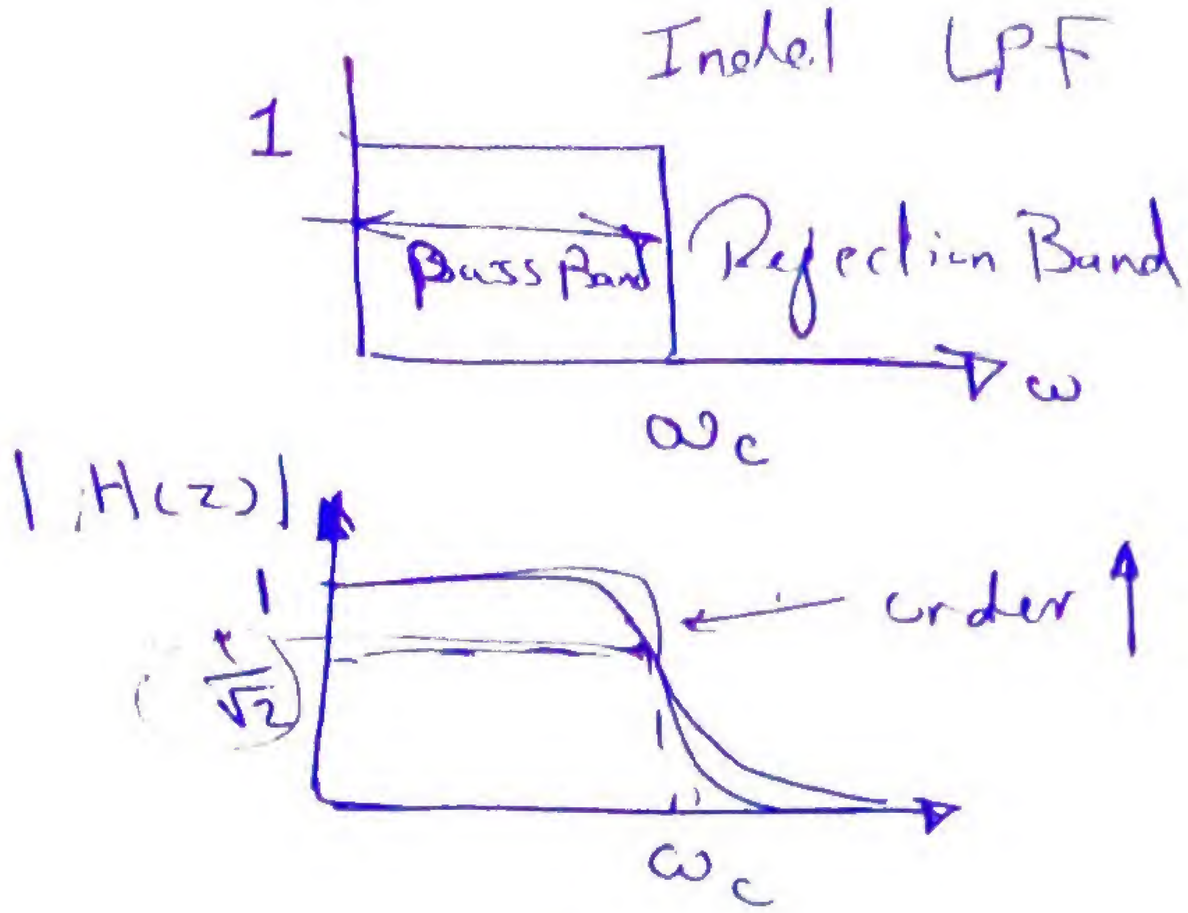
[3] Design a second order digital Band Pass Filter with the following specifications:

- An upper cutoff frequency of 2.6 KHz
- A Lower cutoff frequency of 2.4 KHz
- Sampling frequency of 8 KHz

[4] Given an analog filter with T.F

$H(s) = \frac{3}{s+3}$, convert it to Digital filter with sampling period $T = 0.04$ sec.

Filter design



→ order

→ ω_c

↳ Discretization

$$H(z) = H(s)\Big|_{s = \frac{2}{T}\left(\frac{z-1}{z+1}\right)}$$ Bilinear

Specs : ω

Analog ✓

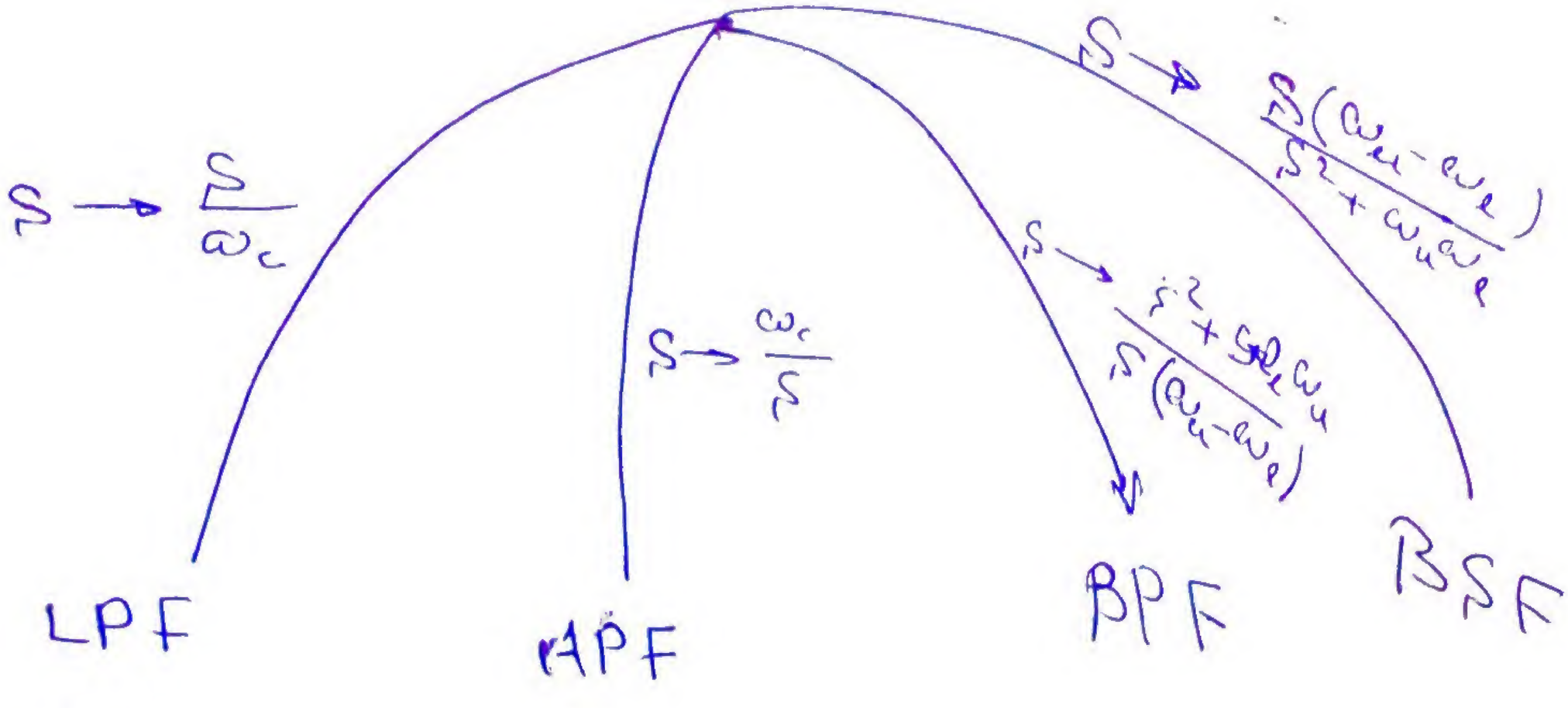
Digital

$$\omega_{ca} = \frac{2}{T}\tan\left(\frac{\omega_{cd} T}{2} \times \frac{180}{\pi}\right)$$

NLPF ($\omega_c = 1$)

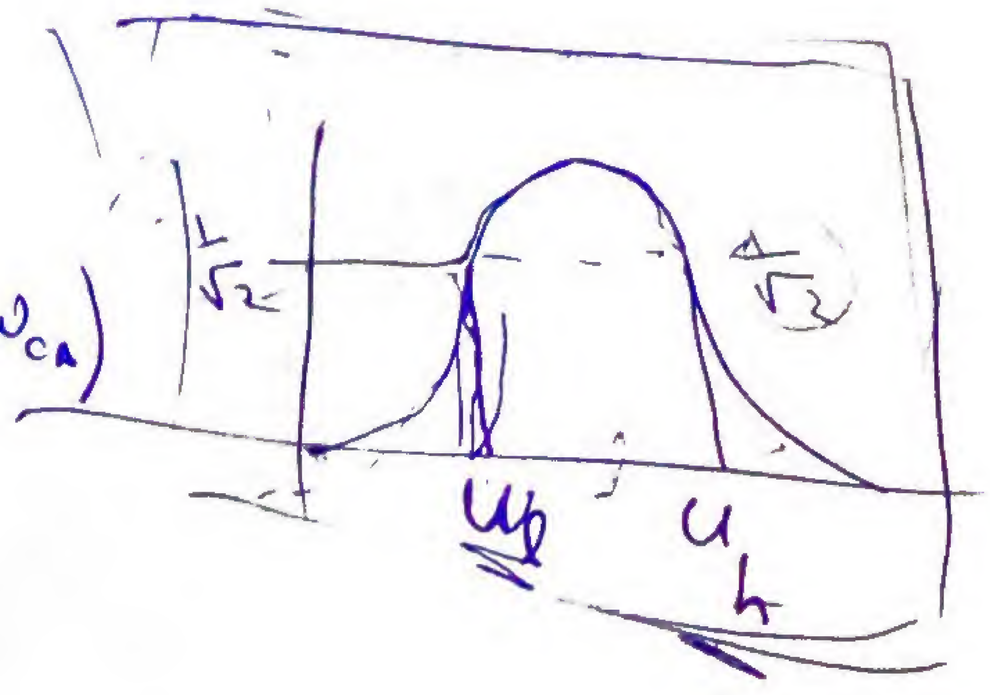
1st order $H(s) = \frac{1}{s+1}$

2nd order $H(s) = \frac{1}{s^2+\sqrt{2}s+1}$



ω_c ω_c

(1) Specs Mapping ($\omega_{co} \to \omega_{ca}$)



(2)

① Transform Digital Specs to Analog Specs ($\omega_D \rightarrow \omega_A$)

② Determine the order of the filter

③ Choose a NLPF according to desired N

④ Mapping to desired type and ω

⑤ Discretization $H(s) \longrightarrow H(z)$

$$s = \frac{2}{T}\left(\frac{z-1}{z+1}\right)$$